circulate. The arthropods have a heart (except in some modified groups), a pericardium, and a large system of hæmocœlic spaces; the crustacea have definite arterial vessels. The arthropods, again, breathe by gills borne on the limbs or by tracheæ. But what Mr. Clark means by the respiratory system of the echinoderms is not clear: they aërate their body fluids in so many ways; such structures as papulæ, when developed, are not much like anything in arthropods. As for the crystalline skeleton of the echinoderms, deposited in the spaces of an interpenetrating mesoderm and resorbed as need arises, it can only be contrasted with the chitinous cuticle of the arthropods, hardened by the deposition of amorphous lime salts, and incapable of modification except through moulting. Lastly, how can the radial segmentation of echinoderms be homologised with the metameric segmentation of the arthropods? Mr. Clark does not tell us. He does, however, accept the general view that "the echinoderms are derived from bilaterally symmetrical ancestors," and he does later on quote Patten's hypothesis that the original metameres of the ancestor were suppressed on one side, and the remainder of the body bent round into a ring, so that the half metameres with their segmental organs became arranged in radiating lines—a hypothesis which places a very strained interpretation on the facts of embryology, and seems inconsistent with Mr. Clark's own views as to the relations of larva and adult.

No one would wish to assert that a study of the development and mode of life of the cirripedes can have no bearing on the origin of the echinoderms. There is much that is suggestive in the comparisons drawn by Patten and by Clark. But if those writers mean to conclude that the echinoderms were derived from the cirripedes by way of the crinoids, then assuredly they have been misled by adaptive resemblances. If they mean only that these resemblances imply a likeness of ancestral material no less than a likeness of external conditions, then we must ask them to indicate the connection between the ancestor of the Crustacea (nauplius-, Apus-, or trilobite-like, as they choose) and the bilaterally symmetrical ancestor (Dipleurula or what not) of the Echinoderma. It is quite possible that there was a primitive group of cœlomate animals from which the early echinoderms and the chætopod ancestors of the arthropods both arose; but to imagine that the arthropod type, once evolved on the "appendicular plan," as Mr. Clark calls it, retraced its steps towards anything that could have become an echinoderm, is contrary to all ascertained principles of evolution; and the alternative dream, that an arthropod, once recognisable as such, could progressively change into an echinoderm, is a baseless and unsubstantiated vision.

Mr. Clark will not, it is to be hoped, think we dismiss him in summary fashion. Many will say we ought to have done so. But there is a reason for treating the matter seriously. Any one has a perfect right to discuss the origin of the echinoderms and to maintain what views he pleases. Mr. Clark, as a distinguished authority on one class of echinoderms, certainly may claim a hearing. But whoever discusses morphological problems should have regard to the recognised principles and methods of morphology. He should have a sufficiently wide knowledge of comparative anatomy to be able to estimate the relative values of the facts that he adduces. There is at the present time a real danger that this discipline may be forgotten in the rush after alluring discovery in genetics, biochemistry, and other novel branches of biology. Among many examples of loose thinking in morphology, this of Mr. Clark occupies a bad eminence, exaggerated by the place of its publication and by the high merit of its author in his own field. F. A. Bather.

Physics for Students.

(1) *An Outline of Physics.* By L. Southerns. Pp. xv + 202. (London: Methuen and Co., Ltd., 1920.) 6*s.* 6*d.*

(2) *General Physics and its Application to Industry and Everyday Life.* By Prof. E. S. Ferry. Pp. xvi + 732. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 24*s.* net.

(3) *Laboratory Projects in Physics: A Manual of Practical Experiments for Beginners.* By F. F. Good. Pp. xiii + 267. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1920.) 9*s.* net.

(4) *An Introduction to Physics for Technical Students.* By P. J. Haler and A. H. Stuart. Pp. 240. (London: Library Press, Ltd., 1921.) 4*s.* 6*d.* net.

(5) *Experimental Science.* 1, *Physics.* By S. E. Brown. Section 5, *Light.* Pp. vii + 273-424. (Cambridge: At the University Press, 1920.) 6*s.* net.

(6) *Elements of Natural Science.* By W. Bernard Smith. Part 1. Pp. viii + 207. (London: Edward Arnold, 1921.) 5*s.* net.

(1) MR. SOUTHERNS has faced the difficulty, which many university lecturers have experienced, of providing a course in physics for college students in their first year. Not only are there great differences in the preliminary knowledge with which the students are equipped, but also different groups—say, engineers and medicals—look at the subject from very different angles. The first year should be a year

of inspiration. Broad outlines should first be presented in an elementary but scientific manner. Part 1 of this book, which is intended to be used in conjunction with a theoretical text-book, aims at giving such a general sketch in which new knowledge is incorporated as an essential part of the course. Part 2 comprises a course of laboratory work suitable for general purposes. In an interesting preface Mr. Southerns has some suggestive observations as to the methods of dividing students into classes, with the view of allowing the better students to undertake more advanced work. Such subdivision is advocated in connexion with both tutorial and practical work. The book has been well thought out, and may be recommended to teachers who have similar problems to solve.

(2) In this new volume Prof. Ferry, who is known as the author of a useful handbook of practical physics, has placed teachers of physics under fresh obligation by providing a text-book for college students "in which especial emphasis is laid on the diverse relations of physics to Nature, agriculture, engineering, and the home. Much of the motivation and illustrative material has not appeared heretofore in any text-book." Even if we do not fully grasp what is implied by the term "motivation," we may admit the general accuracy of this claim. A lecturer on physics in search of novel or up-to-date illustrations should certainly consult this volume. By studying the series of kinetoscope photographs of a freely falling cat and the accompanying letterpress he will learn why the cat alights on its feet. "The recent war has produced many highly important and interesting devices, some of which are here presented to students for the first time." We find, for example, descriptions of acoustic goniometers, based on binaural hearing, for locating invisible submarines and aeroplanes, and of the "radio-compass," by means of which the position of a vessel at sea may be found by wireless signals.

The amount of information that has been packed into these 700 pages is remarkable. But it must not be supposed that this is merely a popular or descriptive book; it is a scientific treatise, and every page bears evidence of the fact that it is the work of one who has considered with care the theory of each subject and the best method of presenting it to the student. A few points of interest may be mentioned. For the familiar "latent heat of fusion" the term "heat equivalent of fusion" is suggested. The paragraph dealing with the black-body temperature scale seems to us to make a simple matter complicated by its treatment of "the black-body temperature of a non-black body." There seems no good reason for speaking or thinking of this as the temperature of the non-black body itself; it is simply the temperature of a black body which emits radiation at the same rate. Electric resistance is discussed before electromotive force or Ohm's law, being measured by the amount of heat developed in a conductor by the passage of unit current for unit time.

There are interesting chapters on the electron hypothesis (including a description of the three-electrode vacuum tube) and on electromagnetic waves. The section on light is excellent; the cardinal points and the aberrations of lenses and lens systems are well treated, as also are various optical instruments. Physical optics claims attention in three interesting chapters. The statement on p. 626 that it is impossible to have a blue sea when the sky is overcast has been contradicted recently by Prof. Raman (Nature, vol. 108, p. 367). The volume contains numerous solved problems in the text, and nearly 700 unsolved problems with answers in an appendix; the illustrations deserve a special word of commendation.

(3) Space is lacking for a full account of the high ideals which have inspired the author of this manual. Suffice it to say that the physics course in a modern (American) high school "should proceed toward an organisation of practical situations, activities, and phenomena, the value of which will be recognised and approved by teachers, students, parents, administrators of education, and others who are responsible for the work which boys and girls do in the high school"! Hence these ninety-five "projects" include the construction of "a model of a kitchen hot-water heater" (*sic*); studies of methods of heating or lighting a room; experiments on electroplating, saucepan conduction, and wireless; studies of the camera, the kerosene stove, the phonograph, and the sewing machine; and lastly a section headed "automobile work" dealing with carburettors, ignition systems, and the engine of a Ford car. Here is a course "organised according to the recognised function of education in a democratic society"! We cannot help feeling a certain amount of envy of the boys and girls in the modern high school.

(4) Messrs. Haler and Stuart have produced an introduction to physics based on experiments which can be carried out with simple apparatus. The scheme is intended to cover a two-years course for technical or trade schools, when two or three hours a week are devoted to the subject. Questions and numerical exercises are plentiful. It is scarcely logical to say that the absolute zero of temperature would be reached at $-273°$ C. when the only scale of temperature that has been described is that of the mercury thermometer.

(5) Mr. S. E. Brown has prepared a useful course on light to occupy two terms for pupils about fourteen years of age. There are plenty of experiments and illustrations, and the Barr and Stroud range-finder is

shown as a frontispiece. Teachers will welcome the large collection of examples and revision questions.

(6) Part I of the "Elements of Natural Science" includes mechanics, chemistry, heat, properties of matter, light, and sound. With part 2 the course is intended to cover the "general science" syllabuses of School Certificate and Army Entrance Examinations. The treatment of the subject-matter, together with the experiments in illustration, should prove successful in exciting and maintaining the interest of the student.

H. S. A.

Parasitism and Symbiosis.

Le Parasitisme et la Symbiose. Par Prof. M. Caullery. (*Encyclopédie Scientifique: Bibliothèque de Biologie Générale.*) Pp. xiii+400+xii. (Paris: Gaston Doin, 1922.) 14 francs net.

FEW zoologists are so well qualified as Prof. Caullery, who is editing the series of works on general biology to which the volume under notice belongs, to survey the range of parasitism and symbiosis. He is the pupil and successor at the Sorbonne of Alfred Giard, and like him is distinguished by a remarkable versatility, having brilliantly investigated the life histories of parasites belonging to many phyla. In his laboratory, too, there was largely carried out the work of Guyenot on aseptic life, which is fundamental for future attempts to solve the problems of symbiosis.

There are good modern treatises on medical parasitology, but these naturally concern themselves with a much narrower field than that required by the student of general biology for whom this book is designed. Throughout, it is characterised by an admirable lucidity, and the vast amount of information it contains does not interfere with the well-balanced arrangement. Recent research which has a general bearing on parasitism is presented with great care, and the bibliography is complete and invaluable.

Commensalism, parasitism, and symbiosis are dealt with successively as related phenomena. The series of more or less modified parasites which exist in many animal groups offer perhaps the most striking illustrations which can be given of the reality of evolution. Prof. Caullery has treated the groups he knows best in detail from this standpoint. The adaptation of the parasitic isopods (especially Entoniscidæ) to their diverse hosts, the evolution of the Rhizocephala in the cirripedes, and the clear series of parasites in the gasteropods are given the attention they deserve. There might also have been included with advantage an account of the passage in the nematodes from forms with a perfect alimentary canal through the intermediate group of the Mermithidae to those complete parasites which absorb food only through the skin.

Passing over the very useful chapters on the various types of parasitic life-history, the migrations of "heteroxenous" forms, and the adaptations for reproduction in parasites, there follows an interesting discussion of specificity of parasites, especially in connection with human interference with the distribution of insects and the parasites they convey. We miss a reference to the very rigid specificity which is stated to exist in the Mallophaga, occurring on birds. Here the association of host and parasite apparently took place at an early stage in the evolution of both groups, and the well-marked systematic relationships of the different Mallophaga actually throw light on those of the bird genera on which they are found.

In the chapters on symbiosis reviews are given of the large number of cases recently described where unicellular symbiotes are found in different invertebrate groups, and then of the extraordinary extension of research on these lines by Pierantoni and Portier. The claim of the latter that every living cell contains symbiotic organisms was seriously considered and rejected by a committee of French biologists, but interest in research on symbiosis is still intense in France.

F. A. POTTS.

Our Bookshelf.

Anleitung zur mineralogischen Bodenanalyse. Von Dr. Franz Steinriede. Zweite umgearbeitete und erweiterte Auflage. Pp. viii+240. (Leipzig: W. Engelmann, 1921.) 60 marks.

THE original appearance of this book in 1889 marked the first serious attempt to apply petrological methods to the study of the minerals of the soil. During the thirty-two years that have since elapsed, petrological methods have undergone considerable development, while, on the other hand, our knowledge of the soil has similarly been enormously extended. The development of these two subjects, however, has proceeded mainly on quite separate lines, particularly in this country, where soil investigators have studied chiefly the chemical and biological aspects of soil fertility. That our present methods of examination of soil frequently fail us in accounting for observed differences in fertility is an indication of the need for new methods of attack, among which mineralogical analysis is undoubtedly of importance.

The appearance of the new edition of a book by a pioneer in the subject is thus welcome, especially as no similar book exists in this country. The author gives a succinct but adequate account of all the important aspects of the subject, including elutriation and flotation methods of separation, optical and other physical as well as chemical methods of examination. The data for the application of these methods are collected in a series of useful tables, together with a